Liquefaction of sands and its effects on buried structures

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1. Project Description

Background

In regions of high seismic activity, soil liquefaction has been identified as a major hazard to buried structures [1, 2]. Liquefaction has been defined as the transformation of cohesion less material from a solid state into a liquefied state as a consequence of increased pore pressure and reduced effective stress. Liquefaction of a soil deposit does not necessarily mean that ground failure occurs, but when liquefaction is combined with certain geologic conditions, it can lead to large permanent ground movement and soil failure. Conditions most conducive to liquefaction involve loose cohesion less granular deposits combined with a high water table [3, 4].

Lateral spreading and settlement are one of the most common forms of ground deformation associated with liquefaction during earthquakes [5]. Lateral spreading and settlement pose special problems for buried constructions in areas subject to earthquakes [6]. For the siting and design of underground constructions like piles and pipelines in seismic regions, it is important to identify areas susceptible to liquefaction [7].

Over the years, some of the most substantial, and costly damages to the early slopes and the foundation of structures has been due to liquefaction of sands during earthquakes [8, 9]; hence, it is imperative to take countermeasures against liquefaction and suggest an approach to combat it such that while the soil liquefies, the damage is minimum[4, 10].

2. Aims

The aim of this project is to:

a) To examine the influence of various factors on the liquefaction susceptibility of sandy sites and the magnitude of associated ground deformations (settlement, lateral spreading);

b) To investigate the effect of the liquefaction on buried structures (piles, pipelines); and

c) To assess the effectiveness of various countermeasure techniques.

3. Research Methodology

This project will be carried out in two stages so as to ensure achieving reliable and accurate results. The main focus of this project will be on Ottawa and Nevada sand as these kinds of sands are so popular in this topic. Moreover, a majority of scientists have done their research on this sand in liquefaction topic and it can give me more chance to validate the results of project with other works. In the first stage, a table model for the seismic laboratory will be constructed and tests will be run. In the second stage, upon completion of testing, the settlement of liquefaction, lateral spreading, pure water pressure and the effect of the geometry of the pipe on the capacity of the different layers of soil liquefaction potential will be evaluated through displacement. After analysing the experimental results, the laboratory model will be modelled through numerical simulation with FALC program and the model will be appraised based on input parameters. Finally, the numerical model will be estimated by comparing the experimental and numerical model. Then, diverse elements including the settlement of liquefaction, lateral spreading, pure water pressure and effect of the geometry of the pipe on the capacity of the different layers of soil liquefaction potential will be evaluated based on changing parameters by means of software numerical. In addition, there are other factors that can be assessed during testing experimental model.
Parameters include:
1- The effect of loading frequency
2- The effect of underground constructions materials
3- The effect of the thickness of underground structures

4- The effect of soil dilation angle
5- The effect of thick layer of liquefaction
6- The effect of diameter pipe
7- The effect of buried deep underground structures
8- The effect of damping Soil
9- The effect of the relative density of soil
10- The effect of underground water level

4. Significance

Small-scale modelling of a full-scale prototype offers advantages in that the model may be constructed more easily, thus saving time and money, and the model test may be conducted in a controlled environment.

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